SPECIFIC PROCEDURES FOR CLEANING SELECTED TYPES OF EQUIPMENT 3.3

By **A.J. Horowitz, M.W. Sandstrom, and F.D. Wilde**

The equipment-cleaning steps described in sections 3.2.1 and 3.2.2 apply to most, but not all, equipment. This section describes the cleaning procedures needed for specific equipment for which the general protocols are modified or do not apply, or for which more detailed instructions might be useful. Wear appropriate disposable, powderless gloves throughout each cleaning procedure, changing gloves with each change in cleaning solution and as described in section 3.2.

INORGANIC-SAMPLE BOTTLE CLEANING PROCEDURES 3.3.1

Bottles for samples to be analyzed for inorganic constituents include translucent colorless polyethylene, opaque brown polyethylene, and transparent glass bottles.Translucent polyethylene bottles that were acid rinsed at the laboratory should arrive capped with colorless, translucent plastic caps. Glass bottles for samples for mercury analysis also are acid rinsed and should arrive capped.

- Discard acid-rinsed bottles that are received uncapped.
- A cleaning procedure is required for bottles that will contain samples to be analyzed for trace elements and is recommended for bottles that will contain samples to be analyzed for major ions and nutrients.

Before leaving for the field, clean polyethylene and glass sample bottles, including acid-rinsed bottles, as described in the steps that follow:

1. Put on powderless, vinyl gloves.
2. Fill each bottle about one-quarter full of DIW and cap.
3. Shake vigorously and decant DIW.

4. Repeat the DIW rinse (Steps 2 and 3 above) two more times.
5. Following the last rinse, fill each bottle half full with DIW and cap the bottle.
6. Rinse exterior of bottle with DIW and dry with lint-free laboratory tissue.
7. Store bottles in doubled plastic bags.

3.3.2 CHURN SPLITTER CLEANING PROCEDURES

Plastic churn splitters are used primarily for samples to be analyzed for inorganic constituents (NFM 2). Avoid the need to field-clean the churn splitter by using a separate, precleaned churn splitter at each field site to be sampled, if possible.

When using the detergent wash/tapwater rinse for the churn splitter—Office-laboratory procedure (fig. 3-2, Step 2):

1. Fill churn splitter through the funnel with detergent solution.
2. Soak for 30 minutes.
3. Scrub interior and exterior surfaces with a soft brush, taking care not to abrade the surface.
4. Pay particular attention to cleaning the paddle and the area around the spigot.
5. Make sure spigot and funnel are free of sediment, including fine particulates (clay), organic matter, and stains.
6. Drain some of the cleaning solution through the spigot before discarding the remaining solution.
7. Fill churn through the funnel splitter about one-third full with tapwater; swirl and shake churn vigorously to remove detergent residues. Allow tapwater to pass through the spigot.
8. Repeat rinse procedure until no bubbles remain in rinse water after the water is agitated.

When using the acid rinse for the churn splitter—Office-laboratory or field-site procedures (figs. 3-2 and 3-3, Step 4):

1. Do not allow acid solution to contact the outside of churn splitter, or the churn spigot.

2. Do not pass acid solution through the spigot.

3. Decant acid solution by pouring out of the top of the churn into the neutralization container.

When using the DIW rinse for the churn splitter—Office-laboratory or field-site procedures (figs. 3-2 and 3-3, Step 5):

1. Fill the churn splitter through the funnel with DIW to about one-third full.

2. Swirl the DIW vigorously and pour it out of the top of the churn into the neutralization container.

3. Repeat the fill-and-swirl procedures of 1 and 2 above at least twice, checking the pH of the DIW after each swirl with narrow-range pH indicator strips.

4. Pass a portion of the DIW through the spigot only after the DIW pH equals or is greater than either 6.0 or the pH of the DIW before acidification. Pour the rest of the DIW into the neutralization container.

For storage of a cleaned churn splitter—Office-laboratory or field-site procedures:

1. Package a clean, dry churn splitter in two new plastic bags and loosely tie or secure with a nonmetal clip. If a churn splitter must be packaged while wet, use within 1 to 3 days and (or) keep chilled to prevent bacterial growth.

2. Place entire package into the churn carrier.

3.3.3 CONE SPLITTER CLEANING PROCEDURES

The fluorocarbon-polymer cone splitter (NFM 2) is appropriate for splitting samples for inorganic or organic analyses. When cleaning the cone splitter (Office of Water Quality Technical Memorandum 97.03), pay particular attention to removing foreign material from threaded and hard-to-access parts. Field cleaning can be minimized by having separate, precleaned cone splitters available for each site and by keeping a supply of clean tubes to replace the used tubes for each site to be sampled.

When inorganic constituents will be analyzed in samples processed through the cone splitter:

Office laboratory. Follow the steps as described for figure 3-2.

Field site. Referring to figure 3-3:

1. Prepare the field site as described in section 3.2.1. Put on disposable, powderless gloves.
2. Rinse the splitter thoroughly with deionized water.
3. Inspect the cone splitter. If it looks dirty, is suspected of being contaminated, or was allowed to dry between field sites without a thorough DIW rinse, or if the splitter will be used for sampling both inorganic and organic analytes, use the detergent-wash option. Change gloves.
4. Acid rinse by passing 1 L of 5-percent HCl solution through the cone splitter. Collect used acid solution into a neutralization container. Change gloves.
5. Rinse the cone splitter with at least 3 L of deionized water. Collect the rinse solution into a neutralization container. Change gloves.
6. Allow the cone splitter to dry and then store in a clean plastic bag. Seal the bag and store in a second plastic bag or plastic storage container for transport to the next site. A cone splitter that is packaged into bags while wet should be used within 1 to 3 days and (or) kept chilled to prevent bacterial growth.

When organic compounds will be analyzed in samples processed through the cone splitter (fig. 3-4):

Office Laboratory. Follow the steps described for figure 3-4.

Field Site.

1. Prepare site as described in section 3.2.2. Put on appropriate disposable, powderless gloves; if a solvent will be used, select gloves that will withstand contact with the solvent.
2. Detergent wash and rinse equipment as described for figure 3-4.
3. Check equipment and sampling requirements. If splitter will also be used for inorganics sampling, follow acid-rinse directions before rinsing with methanol or other organic solvent.
4. Proceed with the methanol (or other organic solvent) rinse, if required (section 3.2.2).
   - Do not use any organic solvent if the cone splitter will contact samples for analysis of TOC, DOC, or SOC.
   - If samples processed through a splitter will be analyzed for TOC, DOC, or SOC, rerinse the splitter thoroughly to completely remove residues from the detergent wash. Use PBW, VBW, or other organic-grade water for the final rinse if complete methanol evaporation is impractical. If the cone splitter will not be used to process samples for inorganic constituents at the next site, wrap nozzle and other orifices in aluminum foil.

For storage of a cleaned cone splitter:

1. Allow the cone splitter to air dry.
2. Place the cone splitter into a clean plastic bag and seal.
3. Store in a second plastic bag or plastic storage container for transport to the next site.

If a cone splitter must be packaged while wet, use within 1 to 3 days and (or) keep chilled to prevent bacterial growth.

3.3.4 FILTRATION EQUIPMENT CLEANING PROCEDURES

Filtration equipment includes disposable capsule filters and various plate-filter and pressure-filter assemblies. Cleaning procedures for these types of equipment are described below.

3.3.4.A Disposable Capsule Filter Cleaning Procedure

The disposable capsule filter has a one-time use for processing samples to be analyzed for inorganic constituents but must be cleaned before use. The filter can be prerinsed in the office laboratory instead of at the field site as long as it is kept chilled and used in less than 1 day. After filtering the sample, clean or replace the sample-delivery tubing and discard the capsule filter. The cleaning procedure described below comprises sufficient cleaning of the filter for analysis of inorganic constituents at the parts-per-billion (ppb) concentration level (Horowitz and others, 1994).

To clean the disposable capsule filter, pump 1 L of DIW to the filter through precleaned tubing (section 3.3.5) as follows (refer to NFM 5.2.1.A for additional instructions):

1. Use Clean Hands/Dirty Hands techniques described in NFM 4. Remember: the Dirty Hands team member performs operations that are outside of the processing chamber and the Clean Hands team member performs operations that are inside the chamber. Put on disposable, powderless gloves.

2. In a processing chamber, remove the capsule filter from the protective bags. Attach pump tubing to the inlet connector of the capsule filter, keeping the tubing as short as possible. Make sure the direction of flow through the capsule filter matches the direction-of-flow arrow on the side of the filter.

3. Pump 1 L of DIW through the capsule filter; discharge waste rinse water through a sink funnel or to a toss bottle.

   - Operate the pump at a low speed.
   - Hold the capsule filter so the arrow is pointing up at an acute angle from the horizontal plane. (This expels trapped air from the capsule; do not allow water to spray onto chamber walls.)

4. Remove tubing from the DIW reservoir and continue to operate the pump in the forward, mid-range speed position to drain as much of the DIW that remains in the capsule filter as possible. While the pump is operating, shake the capsule filter to help remove any entrained DIW.

5. Detach the capsule filter from the peristaltic pump tubing, put into a clean, sealable plastic bag, and store chilled until ready for use at the next site.

Plate-Filter Assembly Cleaning Procedure 3.3.4.B

To clean filtration equipment used for samples to be analyzed for inorganic or organic analytes, consult sections 3.2.1 and 3.2.2, respectively. Use Clean Hands/Dirty Hands techniques, as appropriate (NFM 4).

- Preclean in the office laboratory one plate-filter assembly per site to be sampled, if possible, in order to save the time that would be needed to clean the plate-filter assembly during the field effort.
- During the detergent wash and (or) DIW rinse, pay particular attention to grooves and crevices, O-rings, and support structures for the filter, where sediment or organic matter might be lodged. Detergent wash and DIW rinse the pressure valve.
- Remove and discard the used filter at the field site; rinse the filter assembly immediately with DIW while still wet from filtering the sample, even if a clean filter assembly is available for the next site.

When field cleaning the plastic plate-filter assembly:

1. Disassemble the plate-filter assembly inside the processing chamber while it is still wet from the sample water and while wearing disposable, powderless gloves.

   a. Remove the used filter media carefully to avoid spilling any of the filter cake.

   b. Place the filter media into a sealable plastic bag. Seal and pass the bag out of the chamber. Change gloves.

2. DIW rinse all components of the plate-filter assembly, including the exterior and interior of the tubing and the pressure valve, dispensing the DIW from a wash bottle. Pay particular attention to grooves and crevices, O-rings, and support structures for the membrane filter, where inorganic or organic materials might be lodged. Change gloves.

3. Inspect the plastic plate-filter assembly. Use the detergent-wash option described in figure 3-3 (Step 2) if the filter assembly looks dirty, is suspected of being contaminated, or was allowed to dry after use without first rinsing thoroughly with deionized water.

4. Reassemble the plate-filter assembly, reattaching the piece of tubing to the outlet of the filter assembly and placing the discharge end of the tube through the drain or disposal funnel in the bottom of the processing chamber to the acid-neutralization container. Reconnect the filter assembly to the peristaltic pump with the sample tubing. Change gloves.

5. To acid rinse the plate-filter assembly, pump 1 L of 5-percent HCl solution (or 10-percent HNO_3^- solution) through the plate-filter assembly. Check that the acid solution is being discharged into the acid-neutralization container. Alternately squeeze and release the tubing at the outlet to force the acid solution to cover and rinse all interior surfaces of the filtration assembly. (Be careful not to force tubing from the outlet by squeezing tubing for too long.)

6. To DIW rinse the plate-filter assembly, pump 2 L of deionized water through the assembly, using the same squeeze-and-release method described above in 5 for the acid rinse. Ensure that all the rinse water is being discharged to the acid-neutralization container. After confirming that the pH of the acid rinse solution is greater than 6.0 or the original pH of the DIW, appropriately discard solutions from the neutralization container.

7. For storage, place the cleaned plate-filter assembly and tubing into clean double bags for temporary storage until use at the next site. If wet when bagged, store for no longer than 24 hours and (or) chill to prevent bacterial growth. The filter assembly must be dry if stored for more than 24 hours.

Always remove the used filter media from the plate-filter assembly before cleaning and storage.

When field cleaning the aluminum plate-filter assembly, use the general cleaning instructions in section 3.2.2 for figure 3-4, as follows:

1. Inspect the aluminum (or stainless steel) plate-filter assembly for damage or excessive contamination and replace if necessary.

2. Wearing disposable, powderless gloves, prepare the area to be used for cleaning the plate-filter assembly by lining the table or counter surface with aluminum foil.

3. Disassemble the filter assembly and remove the used glass-fiber filter media carefully to avoid spilling any of the filter cake. Place used filter media into a sealable plastic bag, seal the bag, and put aside for disposal. Place components of the plate-filter assembly and tubing into a washbasin for detergent. Change gloves.

4. Detergent wash by using a 0.1- to 0.2-percent nonphosphate-detergent solution. Scrub each component of the filter assembly with a soft brush to remove any adhering material such as oil and grease, sediment, algae, or chemical deposits. Pay particular attention to grooves and crevices, O-rings, and support structures for the glass-fiber filter, where inorganic or organic materials might be lodged. Pump detergent solution through tubing. Place components of the plate-filter assembly onto a clean, aluminum-foil-covered surface.

5. Discard detergent solution from basin, rinse basin with tapwater, and place components of the plate-filter assembly into the basin. Change gloves.

6. Rinse each component thoroughly to remove detergent residue, paying particular attention to grooves and crevices. Use a wash bottle filled with DIW or tapwater to rinse hard-to-reach places. Place rinsed components onto a dry section of clean aluminum foil or basin. Change gloves. If the assembly will be rinsed with

methanol or other organic solvent, change to disposable, solvent-resistant gloves, and place components of the filter assembly into a clean, solvent-resistant washbasin. +

7. Rinse plate-filter assembly components with pesticide-grade methanol or an equivalent grade for other organic solvents. Do not methanol rinse any tubing or filtration assembly to be used for collecting or processing samples for TOC, DOC, or SOC analysis. The instructions for the methanol rinse apply also for use of any other organic solvent. Rinse the equipment with methanol while outside of the field vehicle and downwind of sampling activity.

   a. Dispense methanol from a fluorocarbon-polymer wash bottle. Rinse all sample-contacting surfaces of filter-assembly components and tubing over a solvent-resistant basin or waste container. Methanol-laced rinse water must be collected into an appropriate waste container designed for flammable liquids.

   b. Place methanol-rinsed equipment components onto a clean aluminum foil surface to air dry. (Cover equipment components loosely with an aluminum foil tent, if concerned about airborne contaminants.)

8. Reassemble the plate-filter assembly. Wrap nozzles with aluminum foil and seal filter assembly in plastic bags. Double bag for transport or for long-term storage. +

3.3.4.C Pressure-Filter Assembly Cleaning Procedure

The cleaning procedures described in section 3.2.2 for figure 3-4 do not apply to the filtration assembly used for samples to be analyzed for DOC and SOC. The filtration assembly for processing organic-carbon samples is a gas-pressurized apparatus constructed of either stainless steel or fluorocarbon-polymer material.

- Do not bring the pressure-filter assembly in contact with methanol or other organic solvent or organic-solvent vapors.
- In general, office-produced organic-grade water that is prepared by being passed through appropriate columns to remove organic compounds is of adequate purity for cleaning this equipment. PBW or VBW also can be used. Office-produced organic-grade water, however, must not be substituted for blank samples. +

▶ Do not clean the pressure-filter assembly with detergent. Exception: see Step 3 below.

When using office-laboratory or field-site cleaning procedures for cleaning the pressure-filter assembly:

1. Wearing disposable, powderless gloves, disassemble the pressure-filter assembly before it dries and place components into a clean washbasin. Change gloves.

2. Using office-produced organic-grade water, thoroughly rinse the pressure-filter assembly and place it into a washbasin or onto a clean surface. Generally, these steps are sufficient to field clean the pressure-filter assembly.

   - If necessary, use a soft-bristled toothbrush to remove sediment, chemical deposits, and other foreign material from threaded components, gaskets, O-rings, support screens, grooves, and nozzles. Take care not to scratch or mar inner surfaces when scrubbing.

   - Rinse the pressure-filter assembly thoroughly with office-produced organic-grade water or PBW or VBW.

3. If the pressure-filter assembly is very dirty or contaminated, clean as follows:

   a. Disassemble and soak assembly for at least 1 hour in a 0.1-percent solution of nonphosphate laboratory-grade detergent.

   b. Scrub with a soft-bristled toothbrush, as described above in 2.

   c. Rinse repeatedly with office-produced organic-grade water, being sure to remove all traces of detergent.

4. Place all components of the pressure-filter assembly onto aluminum foil and allow to air dry thoroughly under a protective aluminum foil tent.

5. Reassemble the pressure-filter assembly, wrap nozzles in aluminum foil, and seal in a storage bag.

Do not use methanol or other organic solvents on the equipment used to filter samples for organic-carbon analyses.

3.3.5 SAMPLE TUBING CLEANING PROCEDURES

Cleaning procedures are described below for the tubing and nozzles used with peristaltic and valveless metering pumps. Cleaning procedures for submersible pump tubing are described in section 3.3.9.B. Wear appropriate, disposable, powderless gloves throughout the cleaning process, changing gloves with each change in cleaning solution as indicated throughout section 3.2.

- Preclean the number of tubing sections needed at each site in the office laboratory rather than recleaning tubing in the field, in order to save time during field work. Place into doubled plastic bags and store tubing dry or store wet tubing chilled to prevent bacterial growth. If bacterial growth is present, reclean tubing before use.
- Use disposable tubing if possible, especially at contaminated sites, to avoid the cleaning process and prevent the possibility of cross contamination.

When using office-laboratory or field-site procedures for cleaning plastic (including fluorocarbon-polymer) sample tubing used for samples to be analyzed for inorganic constituents, follow the general sequence of procedures described for figures 3-2 or 3-3, and those described for filtration assemblies (section 3.3.4).

To summarize the key steps for figures 3-2 or 3-3:

1. Pump 1 L of 5-percent HCl solution through the tubing, discharging the used acid solution into a neutralization container. Pinch and release tubing near tubing outlet while pumping the acid through to ensure that all interior surfaces are acid rinsed.
2. Pump 2 L of DIW through tubing, using the same pinch-and-release method. Discharge used DIW to an acid-neutralization container, and check that the rinse-water pH is greater than 6.0 or the original DIW pH.
3. Discard neutralized solutions appropriately.
4. Clean stainless steel connections or metal tubing using detergent-wash and tapwater/DIW rinse procedures.

When using office-laboratory or field-site procedures for cleaning tubing for organic-compound samples:

Follow the general sequence of procedures described for figures 3-1 and 3-4. Proceed with the methanol rinse after the detergent wash and tapwater rinse. If samples also will be collected for inorganic-constituent analysis, however, acid rinse nonmetallic tubing and components after the detergent wash/tapwater rinse and before continuing to the methanol rinse. When cleaning sample tubing:

1. Pump 1 L of nonphosphate, laboratory-grade detergent solution through tubing, followed by sufficient tapwater or DIW to remove detergent residue. Pinch and release tubing near tubing outlet while pumping the solution to ensure that all interior surfaces are cleaned.
2. Place discharge end of tubing from peristaltic or valveless metering pump over methanol waste container.
   - Pass one tubing volume of methanol through the same pump system used for filtration, using the same pinch-and-release method.
   - Short sections of tubing can be held over the waste container while dispensing the methanol from a fluorocarbon-polymer wash bottle instead of pumping the methanol through the tubing.
   - Do not methanol rinse tubing to be used for samples for TOC, DOC, or SOC analysis.
3. Store tubing in doubled plastic bags.

CAUTION: Do not use methanol around equipment that can create electrical sparks (see section 3.3.9.B).

3.3.6 PROCESSING AND PRESERVATION CHAMBERS AND FLOWTHROUGH CHAMBER CLEANING PROCEDURES

Processing and preservation chambers used to protect samples from atmospheric contamination generally are portable and are assembled at the field site. Large, clear plastic bags usually are clipped to the inside of the frame rather than stretched over the frame. Plastic clips are used to hold the cover tightly in place. When the bag is clipped to the inside, it is not necessary to field clean the chamber frame.

The flowthrough chamber, used when monitoring ground-water field measurements, is connected inline to the pump sampler. The flowthrough chamber should be kept free of sediment and dirt or deposits on the chamber walls. Air dry and store the chambers in sealable plastic bags.

When cleaning the processing and preservation chambers:

Office laboratory. Clean the frame of portable chambers in the office with detergent solution, then rinse thoroughly with tapwater and dry and store in plastic bags.

Field site. Frames require regular cleaning after each use at a site if chamber covers are stretched over the outside of the frame rather than clipped to the frame.

1. Discard the used bag.
2. Wipe the chamber frame with DIW.
3. Replace chamber cover only when the next samples are ready to be processed.
4. If the processing chamber is a fixed installation, clean out any spilled sample water, solid materials, or wash solutions, and swab down the inside using deionized water and lint-free laboratory tissue.
5. Use detergent solution followed by a thorough tapwater or DIW rinse if a spill has contaminated the chamber.
6. Store chamber frames in plastic bags.

When cleaning the flowthrough chamber:

1. Clean the flowthrough chamber in the office laboratory with detergent solution and rinse thoroughly with tapwater, followed by DIW. Do not use acid solution or methanol.
2. If the flowthrough chamber needs to be field cleaned, remove measurement sensors and clean with a dilute detergent solution; rinse thoroughly with tapwater followed by DIW.

RADON SAMPLER CLEANING PROCEDURE 3.3.7

Soak radon samplers in a detergent solution for 10 minutes and rinse thoroughly with tapwater to remove detergent residue; follow with three to five rinses with DIW. Do not use methanol. Air dry the radon sampler and store in doubled plastic bags.

3.3.8 SURFACE-WATER SAMPLER CLEANING PROCEDURES

Disassemble surface-water samplers for cleaning and follow the sequence of procedures described in section 3.2 and figures 3-2, 3-3, or 3-4, as appropriate.

When using office-laboratory procedures for cleaning surface-water samplers:

1. Periodically disassemble samplers for office-laboratory cleaning. Discard the bag sampler bag after one use—do not attempt to scrub or detergent wash the used bag. Prepare cleaning solutions, cleaning equipment, and cleaning area as described in section 3.2.

2. Soak components in detergent solution for 30 minutes. Put on appropriate disposable, powderless gloves. Scrub components with a soft brush or sponge and rinse thoroughly (section 3.2.1 or 3.2.2). Change gloves.

3. Check the sequence of cleaning procedures shown in figure 3-1.

   a. If the sampler is used for sampling inorganic constituents, soak each nonmetallic component in a 5-percent trace-metal-grade HCl solution for 30 minutes, followed by copious rinsing with DIW (section 3.2.1). Acid rinse only nonmetal parts. Change gloves.

      - Acid must not contact the metal collar on the DH-81 sampler.
      - Make sure that the nozzle is unscrewed from the cap.

   b. If the sampler is used for collecting organic-compound samples, rinse each component with pesticide-grade methanol dispensed from a fluorocarbon-polymer wash bottle and allow to air dry (section 3.2.2). Do not methanol rinse tubing or components that will contact TOC, DOC, or SOC samples. Change gloves.

4. If collecting an equipment blank (section 3.4), change gloves and rinse each component with the appropriate blank water before collecting the blank sample.

5. Reassemble the sampler. If the sampler is dedicated to sampling for organic compounds, double wrap the sampler nozzle in aluminum foil. Place the sampler into double plastic bags and seal for storage and transport.

When using field-site procedures for cleaning surface-water samplers:

1. Unwrap precleaned washbasins (one for each cleaning solution to be used).

2. Disassemble the used sampler into its component parts (bottle, cap, nozzle) so that all of the pieces can be thoroughly wetted with the various rinses. Discard the previously used bag-sampler bag (do not attempt to clean it for reuse).

3. Wearing appropriate disposable gloves, thoroughly rinse the sampler components with DIW. Use a stream of DIW from the wash bottle, if required.

4. Check whether target analytes are inorganic constituents, organic compounds, or both. Review figure 3-1 for the appropriate cleaning sequence.

   a. If a sampler will be used for collecting samples for analysis of inorganic constituents only, change gloves and

      i. Thoroughly rinse the sampler components with tapwater or DIW.

      ii. Acid rinse nonmetallic components over a container using a stream of dilute acid solution from the appropriate wash bottle, if required.

      iii. Thoroughly rerinse the sampler components with DIW over the same washbasin, if possible (see section 3.2.1). Change gloves.

      iv. Place each component on a clean, plastic surface. Pour used acid solution and DIW rinse water into neutralization container.

      v. Check the pH of the solution in the neutralization container. Discard when solution pH is greater than 6.0 or the original DIW pH. Change gloves.

   b. If a sampler will be used for collecting samples for analysis of organic compounds only, change gloves and

      i. Detergent wash, then rinse sampler components thoroughly with tapwater or DIW until agitated rinse water produces no more suds. Change to solvent-resistant gloves.

      ii. Rinse sampler components with pesticide-grade methanol (section 3.2.2), collecting the used methanol into an appropriate container for safe storage until appropriate disposal is arranged.

iii. Place each component on a clean, aluminum-foil-covered surface to air dry and cover loosely with an aluminum foil tent, if airborne contaminants are a concern. Change gloves.

c. If sampler will be used for collecting samples for both organic and inorganic analyses, change gloves and

i. Proceed with a detergent wash and thorough tapwater and (or) DIW rinse.

ii. Acid rinse and DIW rinse nonmetallic components, as described above, discarding used solutions appropriately. Change to solvent-resistant gloves.

iii. Rinse with methanol, if needed, as described above.

iv. Place cleaned items on a clean plastic surface to air dry.

5. Reassemble sampler. If the sampler is dedicated to sampling for organic compounds, double-wrap sampler nozzle in aluminum foil. Place sampler into doubled plastic bags for storage and transport.

Do not use methanol or other organic solvents on equipment used to collect organic-carbon samples.

GROUND-WATER SAMPLER CLEANING PROCEDURES 3.3.9

Ground water is sampled with nonpumping samplers (such as bailers, syringe samplers, and the Kemmerer sampler) and with pumping samplers (such as peristaltic and valveless metering pumps and submersible pumps). Office-laboratory cleaning procedures are used before a sampler is used for the first time, after the sampler has been in long-term storage, and whenever the sampler has become excessively contaminated. Field-site cleaning procedures are used after sampling at a field site and before proceeding to the next sampling site. Caveats and modifications that apply to the general office-laboratory and field-site cleaning procedures (section 3.2) are described in this section. The cleaning procedures used should be documented on field forms.

The rinse with methanol, or other organic solvent, is appropriate only for samplers being used to collect samples for organic-compound analysis. Solvents are never used to clean equipment when sampling for TOC, DOC, or SOC. Dispose of used methanol and all other cleaning solutions appropriately.

TECHNICAL NOTE: Sampler components made of fluorocarbon-polymer plastic generally can withstand a solvent rinse with methanol. Check with the manufacturer before using an organic solvent on pump components constructed of any other plastic material.

3.3.9.A Cleaning of Bailers and Other Nonpumping Samplers

Office-laboratory procedure. Clean nonpumping samplers in a designated area of the office laboratory. Follow the procedures described for figures 3-2 and 3-4, as appropriate for equipment used to sample for inorganic constituents or organic compounds, respectively.

Field-site procedure. Follow the field-site cleaning procedures described for figures 3-3 and 3-4, as appropriate for equipment used to sample for inorganic constituents or organic compounds, respectively.

- Rinse the outside of the sampler with DIW directly after use.
- After filling the sampler with each cleaning solution, shake the sampler vigorously and drain solution through the bottom-emptying device, spigot, or nozzle of the sampler.
- If the sampler looks very dirty or is contaminated, disassemble and clean sampler components using the office-laboratory procedure.

3.3.9.B Cleaning of Submersible Pumps and Submersible-Pump Tubing

The general sequence shown in figure 3-5 is appropriate for cleaning most submersible pumps. The field-site cleaning procedure (described below after the office-laboratory procedure) is sufficient for routine cleaning of the pump in most cases. Collection of blank samples for quality control must be included as a standard protocol for every study in order to document and ensure the efficacy of the cleaning procedure for the field conditions encountered.

- ▶ Fluorocarbon-polymer tubing used to collect water containing large concentrations of volatile organic compounds (VOCs) can be difficult to clean adequately.

- Collect additional blanks if VOC concentrations in last sample collected through the tubing were greater than 500 µg/L.

- Pump tubing should be replaced rather than cleaned if VOC concentrations in last sample exceeded about 700 µg/L.

▶ Most submersible pumps have a stainless steel casing and other metal parts and should not be acid rinsed.

- To clean pumps that are excessively contaminated, a dilute acid rinse followed by copious water rinsing can be used occasionally without damaging the pump.

- Repeated rinsing with dilute acid solution can pit or corrode the pump's stainless steel surface. If the surface appears dulled, the pump must not be used for collecting trace-metal samples.

▶ Lubrication water inside water-lubricated pumps (for example, the Grundfos RediFlo2™) can become contaminated and cause contamination of subsequent samples. Replace the lubrication water with VBW each time after sampling and when cleaning the pump. Follow manufacturer's instructions.

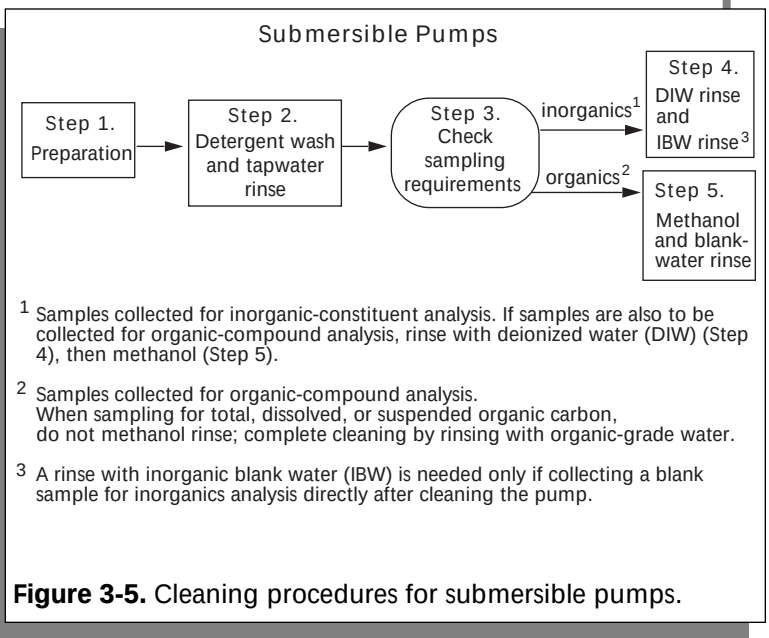

Figure 3-5. Cleaning procedures for submersible pumps.

Office-laboratory pump-cleaning procedure:

Use office-laboratory procedures about once a year and more frequently if results of the pump blank or other information indicate that the pump is contaminated.

Step 1. Preparation.

a. Wearing appropriate gloves, prepare several gallons of a laboratory-grade nonphosphate detergent solution (about 0.1 or 0.2 percent, v/v; use up to 2-percent solution for excessively contaminated pump systems).

b. Preclean washbasins and standpipes (section 3.2).

c. Place pump into sink or waste basin and scrub exterior surfaces with soft brush and detergent solution; rinse thoroughly with tapwater.

d. Disassemble the pump and place components into a detergent-solution washbasin.

Step 2. Detergent wash and tapwater rinse pump components and tubing.

a. Soak pump components in the detergent solution for 30 minutes.

b. Scrub pump components with soft sponge or brush.

c. Rinse thoroughly with tapwater.

d. Raise discharge end of tubing above the rest of the tubing. Using a peristaltic or valveless fluid metering pump, fill the pump tubing with fresh detergent solution until solution rises to the end of the tubing. Plug the tubing end(s).

e. After 30 minutes remove plug from discharge end of tubing and flush detergent solution from tubing by pumping copious amounts of tapwater through the tubing. Change gloves.

Step 3. Check sampling requirements.

+ — If pump will be used for collecting samples for inorganic-constituent analysis, reassemble the pump and go to Step 4.

— Complete Step 4 if pump will be used for collecting samples for analysis of both inorganic and organic analytes before proceeding to Step 5.

— If the pump will be used for collecting samples for organic-compound analyses only, go to Step 5.

Step 4. DIW rinse.

a. Place pump components into DIW washbasin and dispense DIW from a wash bottle to thoroughly rinse all pump components.

b. Using a peristaltic pump and appropriate clean tubing, pump DIW through the sample tubing to rinse.

c. Reassemble pump and connect pump tubing. Change gloves.

d. If collecting equipment blanks to verify that the pump has been adequately cleaned (section 3.4):

+

i. Rinse a clean standpipe dedicated to blank water with blank water.

ii. Insert pump into blank-water standpipe only after pump exterior has been rinsed with blank water or air dried after the methanol rinse.

iii. Pour IBW into the standpipe and pump at least one tubing volume to waste before collecting the blank sample.

+

Step 5. Rinse with blank water followed by a methanol rinse.

a Change to latex or nitrile gloves. Put pump components into solvent-resistant washbasin.

b. Working under a fume hood, dispense methanol (or appropriate solvent) from a fluorocarbon-polymer wash bottle to rinse each pump component and the exterior pump casing. Collect the used solvent into a nonflammable container for storage until disposal.

- Do not reuse methanol or other solvents.
- Work under a fume hood, if possible, or in a well-ventilated area outside of the office laboratory, as methanol fumes can contaminate other equipment.

c. Place methanol-rinsed components on a clean, aluminum foil surface and allow the pump components and casing to completely air dry before reassembling the pump (see section 3.2.2).

d. Using a valveless fluid metering pump and fluorocarbon-polymer tubing, pump about 2 L of methanol through sample tubing and to the methanol waste container.

e. Reassemble the pump and connect the pump tubing. Change gloves and dispose of the methanol-contaminated gloves appropriately.

f. Pour an organic-grade water (PBW or VBW) into a clean PBW/VBW standpipe. Insert pump and pass about two tubing volumes of organic-grade blank water (PBW or VBW) through the pump and tubing to waste.

CAUTION: Pumping methanol or other flammable solvents through an electrical pump system could be dangerous in the event of sparks. Methanol emits noxious fumes and is absorbed through the skin. Wear a mask, safety glasses, and other protective apparel to protect yourself when working with organic solvents.

Field-site cleaning procedure for submersible pumps and pump tubing:

Step 1. Preparation.

a. Preclean the standpipes (one standpipe for each cleaning solution to be used, as described in 3.2.1). The standpipes need to be of sufficient height to supply necessary head for proper pump operation. Separate standpipes are designated for detergent solution and tapwater rinse, DIW rinse, methanol rinse, and blank water (IBW/PBW/VBW). Double-bag each cleaned standpipe for transport to the field site.

b. Estimate the volumes of cleaning solutions and blank water that will be needed for the field effort (refer to fig. 3-6).

c. Prepare the volumes of cleaning solutions needed for the field effort, using appropriate bottles for short-term storage and transport.

The volume of storage in tubing, V_s, of a set of pump-reel and extension tubing can be estimated[1,2] as follows:

$$V_s = [(L_p \times C_p) + (L_e \times C_e) + V_{sp}] \times C_{sp}$$

where,

V_s is volume of storage in tubing, in gallons
L_p is length of pump-tubing segment being cleaned, in feet
L_e is length of extension tubing, in feet
C_p (or C_e) = 0.023 liter per foot for a 3/8-inch inside-diameter (ID) tubing
or = 0.041 liter per foot for a 1/2-inch ID tubing
V_{sp} is volume of solution needed to fill standpipe to minimum level required to operate pump, in liters[1]
C_{sp} = 0.264 gallon per liter.

Examples

Given:

1. L_p - sample-wetted tubing segment is 100 feet for a pump-reel system that has a 1/2-inch ID tubing;
2. L_e - two, 10-foot, 3/8-inch-ID pieces of extension tubing, one running from pump-reel outlet to sample collection chamber, and another running from chamber back to pump-reel (return-flow tubing to standpipe); and
3. V_{sp} - minimum volume[1] of solution required in standpipe to operate pump is 0.8 liter.

To estimate the volume of detergent solution needed for the detergent wash cycle:

$$V_s = [(100 \times 0.041) + (20 \times 0.023) + 0.8] \times 0.264 = 1.4 \text{ gallons}$$

The volume of office-produced deionized water needed to displace detergent solution and the volume of laboratory-produced organic-grade blank water needed to displace 2 liters of methanol just pumped into a system, ideally, would each be estimated to equal V_s[1,2].

[1]Estimate assumes no mixing of two solutions and ignores potential for detergent to adhere to tubing walls. Outflow from the discharge end of tubing should be checked for sudsing to determine that detergent has been removed.

[2]Estimate assumes no mixing at interface of two solutions and ignores potential for methanol to adhere to tubing walls. It is recommended that an additional 0.1 gallon (~ 0.4 liter) of blank water (pesticide-grade blank water or volatile-grade blank water) be used for each 10 feet of tubing to remove methanol residues from sample-wetted sections of tubing. Thus in the example above, another 1.1 (= (100 + 10) x (0.1/10)) gallons (4.2 liters) of blank water would be pumped from the system. This implies a total of about 2.5 (= 1.4 + 1.1) gallons (9.6 liters) of blank water would be used to remove methanol from the equipment setup.

[3]The minimum volume corresponds to the level of solution in the standpipe, which, if maintained, allows pump to operate without introducing air through the pump intake. Once this level is reached, remove pump, and measure this volume.

Figure 3-6. Estimation of cleaning-solution volumes for standpipe, pump, and pump tubing. [From Koterba and others, 1995, table 24.]

Step 2. Detergent wash and tapwater rinse.

a. Put on disposable, powderless gloves (usually vinyl). Rest pump in a washbasin or pail partially filled with detergent solution and clean exterior of pump and tubing with a soft brush. Rinse thoroughly with tapwater. (DIW can be substituted for tapwater, but is less efficient in detergent removal and requires a greater volume of water than tapwater.)

b. Place pump into standpipe, add detergent solution to level above pump intake, and route intake and discharge end of pump tubing to the standpipe.

c. Begin pumping:

   i. Record the pumping rate.

   ii. Record the time it takes to fill the sample tubing.

   iii. Calculate the time it takes for a segment of solution to complete one cycle (fig. 3-6).

d. Circulate detergent solution for about three cycles through the tubing and back to the standpipe. If possible, pump detergent solution through tubing at alternating high and low speeds, and (or) introduce air segments between aliquots of the detergent solution to increase cleaning efficiency.

e. Remove the discharge end of tubing from the standpipe and pump about two tubing volumes of detergent solution to waste, adding fresh solution to the standpipe as needed. Remove pump from standpipe.

f. Rinse detergent from standpipe with tapwater until sudsing stops.

g. Rinse pump exterior with tapwater. Place rinsed pump into standpipe; add tapwater/DIW to level above pump intake. Begin pumping through sample tubing. Do not recirculate rinse water, but add water as needed to maintain water level above pump intake. Continue for five or more tubing volumes. Direct rinse water to waste, away from the vicinity of the wellhead and sampling area and (or) contain as required for disposal.

h. Collect rinse water into a small bottle and stop the pump. Shake the bottle—if sudsing is observed in the rinse water, continue the rinse procedure until no suds appear in the rinse water. Change gloves.

Step 3. Check sampling requirements.

— If a pump will be used to collect samples for inorganic-constituent analysis, go to Step 4.

— Complete Step 4 if a pump will be used to collect samples for analysis of both inorganic and organic analytes and go to Step 5.

— If a pump will be used to collect samples for organic-compound analysis only, go to Step 5.

Step 4. DIW rinse.

A separate DIW rinse is not required if DIW was substituted for tapwater.

a. Use a clean DIW-dedicated standpipe, not the tapwater standpipe, and rinse with DIW. Rinse pump exterior with DIW to remove any detergent residue. Place pump into the DIW standpipe and add DIW to level above pump intake. Change gloves.

b. Start pumping DIW. Rinse DIW through sample tubing without recirculating, using about 3 tubing volumes of DIW. Keep the DIW level above pump intake.

c. Collect DIW rinse water in a clean bottle, shake, and check for suds. Continue to DIW rinse until rinse water is free of suds.

d. If collecting field blanks to verify that the pump has been adequately cleaned (section 3.4):

   i. Change gloves. Rinse clean blank-water standpipe with IBW. Rinse pump exterior with blank water.

   ii. Place pump into the standpipe and add IBW to cover the pump intake.

   iii. Turn on pump and displace any water residing in the pump and tubing. Continue pumping IBW for one tubing volume before collecting the blank sample.

Step 5. Methanol rinse.

Make certain that the pump or other nearby electrically powered equipment is grounded, the power cord is intact, and potential sources of sparks do not exist before rinsing pump with methanol.

TECHNICAL NOTES:

- Inspect the integrity of the seals and O-rings on the pump-motor/pump-body housing. Water inside the motor housing may indicate that methanol vapors could enter the motor. Direct-current motors inherently spark because of the commutator ring. AC motors might spark if the insulation is frayed or burnt on the motor windings or any associated wiring.

- If flammable liquids are required for cleaning electrical pump systems, use extreme caution. Vapors from solvents such as methanol can ignite if a disruption in the motor lead-insulation system occurs in the vapor-enriched zone. (Ignition from a spark from an AC induction-type motor in good operating condition is not a concern if rated as using the National Electrical Code (NEC) at Class 1, Group D.[5])

a. Change to latex or nitrile gloves. Wear safety glasses and apron. Work in a well-ventilated area outside of the field van and downwind of the sampling area.

b. Place pump into a clean, dedicated, solvent-resistant standpipe and route discharge end of sample tubing to a methanol waste container. Add methanol solution to level above pump intake.

c. Pump about 2 L of methanol through sample tubing into methanol waste container, keeping the level of solution above pump intake. The operator should stand back from the pump as a safety precaution in the event that an electrical spark ignites the methanol. Carefully put any unused methanol from bottom of standpipe into methanol waste container. Let methanol in the standpipe evaporate to dryness. Change gloves.

[5]NEC Class 1; Group D: Areas in which flammable gases or vapors may be present in the air in sufficient quantities to be explosive; atmospheres such as acetone, alcohol, ammonia, benzene, benzol, butane, gasoline, hexane, lacquer solvent vapors, naphtha, natural gas, propane, or gas or vapors of equivalent hazard (Cole-Parmer Instrument Company, 1997).

d. Rinse pump exterior with organic-grade water and place pump into standpipe. Add organic-grade water to the standpipe to push the methanol out of the tubing and into the methanol waste container. Pump at least an additional 0.1 gallon (about 0.38 L) of organic-grade water through the system for every 10 ft (about 3.05 m) of methanol-wetted tubing to the methanol waste container after used methanol is collected.

   TECHNICAL NOTE: The recommended organic-grade water is PBW or VBW (supplied by NWQL for blank samples). Office-produced organic-grade water might not be of adequate purity, especially after being stored, and its use requires collection of additional blank samples for quality control (see section 3.4).

e. Repeat d above with blank water (PBW or VBW) pumped from a blank-water standpipe if blank samples will be collected for analysis of organic compounds.

Use of methanol is not recommended as a routine procedure for field cleaning of the pump. A methanol rinse is most safely accomplished as an office-laboratory procedure.

Storage of the cleaned submersible pump and tubing:

1. Place pump into two clean, noncontaminating storage bags and close bags.
2. Cover the pump reel and tubing with doubled plastic bags or sheeting for transport to the next site.

For long-term storage (longer than 3 days), the pump and exterior and interior of the tubing must be dry before being placed into plastic bags. Tubing can be dried by blowing filtered air or filtered (inert) gas through the tubing. If tubing cannot be dried, store chilled to prevent bacterial growth. If bacterial growth has occurred, reclean before use.